IS 6907 (1992): Method of sampling steel castings [MTD 13: Ores and Raw Materials]

BLANK PAGE

IS 6907 : 1992
(Reaffirmed 2002)

भारतीय मानक

इस्पात ढलाइयाँ — नमूने लेने की पद्धतियाँ

(पहला पुनरीक्षण)

Indian Standard

STEEL CASTINGS — METHODS OF SAMPLING

(First Revision)

UDC 669·14 - 14 : 620·113

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110 002

April 1992

Price Group 2

Sampling of Ores, Metallurgical and Allied Products Sectional Committee, BSD 7

FOREWORD

This Indian Stand ard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Sampling of Ores, Metallurgical and Allied Products Sectional Committee had been approved by the Basic Standards, Systems and Services Division Council.

The object of this standard is to prescribe methods of sampling and criteria for acceptance for steel castings.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).

Indian Standard

STEEL CASTINGS — METHODS OF SAMPLING

(First Revision)

1 SCOPE

The standard prescribes methods of sampling and criteria for acceptance for steel castings when they are submitted in the form of a batch or a lot for inspection. Broad outlines on statistical aids in the manufacture of steel castings have also been indicated:

2 REFERENCES

The following Indian Standards are necessary adjunct to this standard:

IS No.	*Title*
397 (Part 1) : 1972	Method for statistical quality control during production: Part 1 Control charts for variables (*first revision*)
4905 : 1968	Methods for random sampling
6601 : 1987	Permissible deviations in chemical composition for products analysis of steel castings (*first revision*)
7200 (Part 1) : 1989	Presentation of statistical data: Part 1 Tabulation and summarization (*second revision*)
8800 : 1986	Technical delivery conditions for steel castings (*second revision*)
10645 : 1983	Method for estimation of process capability
12117 : 1987	Norms for classification of steel foundries for quality assurance

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Cast (Melt)

The product of any of the following:

a) One furnace heat,

b) One crucible heat, or

c) A number of furnace or crucible heats of similar composition mixed in a ladle and used for making a casting.

3.2 Batch

A group of castings from the same cast, heat-treated together.

3.3 Lot

All the castings of the same shape and size, belonging to the same grade and manufactured at one place under essentially similar conditions of production.

3.4 Specific Inspection

Specific inspection means the acceptance procedure carried out on the products to be delivered in order to check whether these products would comply with the requirements of the order. For further details reference may be made to **2.1.17.2** of IS 8800 : 1986.

3.5 Non-specific Inspection

Non-specific inspection is inspection carried out by the manufacturer on a cast/batch resulting from the same production process but not necessarily on the products supplied. For further details reference may be made to **2.1.17.2** of IS 8800 : 1986.

3.6 Defect

Failure to meet the requirements imposed on a casting with respect to a single characteristic in the course of visual, dimensional and other inspections.

3.7 Defective

A casting having one or more defects.

3.8 Acceptance Number

Maximum permissible number of defectives in the sample for acceptance of the lot.

3.9 Acceptable Quality Level (AQL)

It is the maximum percentage of defectives that, for the purpose of sampling inspection can be considered satisfactory as a process average.

3.10 Confidence Interval

The interval between two values say, T_1 and T_2 based upon the sample observations such that the probability of the interval including the true value of the parameter is about 95 percent.

4 STATISTICAL AIDS IN STEEL CASTINGS PRODUCTION

Statistical tools are quite useful at various stages in the manufacture of steel castings. They provide objective methods of estimating quality, valueable guidance in monitoring the process parameters and scientific procedures for sampling and decision making with regard to acceptance or rejection of a lot. For qualityimprovement studies and plant level experiments, statistical methods are very crucial in the course of planning and analyzing experimental results and also arriving at correct inferences at optimum cost. Thus statistical methods form part and parcel of a number of quality assurance activities in steel casting unit (*see* IS 12117 : 1987).

The guidelines for checking the input material quality, as well as process control are given in Annex A.

5 LOT INSPECTION

5.0 The Inspection and Testing of Steel Castings (Specific Inspection)

The provisions given in IS 8800 : 1986 shall be complied with for all types of steel castings. However, where a material or product specification lays down different conditions, those conditions shall apply.

It should be noted that the underlying basis of the stipulations pertaining to acceptance sampling inspection would be met provided the process is statistically under control at the manufacturers end. Hence, the purchaser of steel castings should not solely rely on sampling inspection but should also seek evidence of quality assurance as prescribed in relevant clauses of IS 12117 : 1987.

5.1 Visual, Dimensional and Mass Characteristics

5.1.1 All the large and special castings shall be inspected individually for freedom from defects, fettling and dressing, finish, dimensional characteristics and mass of individual items. Castings which are found to be satisfactory with regard to all these characteristics shall be accepted.

5.1.2 In the case of general castings and those which are manufactured in large numbers in a batch, sampling inspection provides an effective and rational method for accepting the lot for visual, dimensional and mass characteristics. For this purpose, it is necessary to have unambiguous definition of defects and also deviations in dimensions. Any casting which has one or more defects with respect to these characteristics as per the relevant specification shall be deemed to be defective. Table 1 gives 3 different sampling plans for AQL 1·5, 2·5 and 4·0 percent. The selection of AQL will depend on the criticality of the characteristics and shall be as specified in the enquiry and the order, or as may be agreed to between the purchaser and the supplier. The details of sampling inspection shall form part and parcel of the contract along with specifications and drawings.

5.1.3 The castings shall be selected at random from each lot. For actual methods of selection by random sampling, reference is invited to IS 4905 : 1968. The selected samples shall be properly identified preferably with the initials of the representatives of the purchaser and the supplier (in case the inspection is done at the manufacturer's end). In any case, the sample castings shall bear the lot, batch or cast number, date of sampling and also other relevant details.

Table 1 Scale of Sampling for Visual, Dimensional and Mass Characteristic

(*Clauses* 5.1.2, 5.1.4 *and* 5.3.1)

No. of Castings in the Lot	Sample Size	AQL 1·5	AQL 2·5	AQL 4·0
N	*n*	a_1	a_2	a_3
Up to 50	8	0	0	1
51-100	8	0	0	1
101-150	13	0	1	1
151-300	20	1	1	2
301-500	32	1	2	3
501 and above	50	2	3	5

NOTE — a_1, a_2 and a_3 stands for the acceptance number for the respective AQL values.

5.1.4 The sample castings selected as per col 2 of Table 1 shall be successively examined for visual, dimensional and mass requirements against relevant specification. The lot shall be considered as conforming to the requirements of these characteristics if the number of defectives does not exceed the corresponding acceptance number given in Table 1.

5.2 Chemical Composition

5.2.1 Samples for chemical analysis from each lot shall be drawn as IS 8800 : 1986. For product analysis 3 samples shall generally be provided and the permissible variation in product analysis from the limits specified in the ladle analysis shall be as given in IS 6601 : 1987.

5.3 Mechanical Tests

5.3.1 The sampling, sample preparation and testing of samples of steel castings shall be as per IS 8800 : 1986. Tests to be carried out and the requirements shall be as per respective specifications.

In case a number of hardness test results are available for each lot or batch, sampling inspection as given in Table 1 may be resorted to at AQL level 1·5 percent.

In non-destructive testing also sampling may be resorted to as per Table 1 with prior agreement between the purchaser and the supplier.

5.4 The lot shall be considered conforming to respective specifications, if the samples drawn satisfy all the requirements as per **5.1** to **5.3**.

ANNEX A
(*Clause* 4)

A-1 INPUT-MATERIAL QUALITY

A-1.1 There are a number of input materials, such as ferro alloys, scrap, refractories, sand, binders and additives, welding electrodes, grinding wheels which are regularly procured by steel foundries. It is important to get an idea about the variation within and between the batches of raw material. When a number of batches have been purchased from a single source, more important physical or chemical characteristics may be studied with the help of histogram to know the pattern of variation. For this purpose, minimum 30 results are required. The data may be summarized in the form of frequency distribution and the mean ($\bar{x}$) and standard deviation (s) values may be calculated as per IS 7200 (Part 1) : 1989. Most of the industrial measurements follow normal distribution which can be generally verified by plotting the histogram. For normally distributed variables one can state that 95 percent of the individual results lie in the range $\bar{x} \pm 2s$. Thus if $\bar{x}$ and s are known from the previous data, this confidence interval $\bar{x} \pm 2s$ helps us to check the results from the future supply of lot or batches. The declared nominal value may also be used instead of $\bar{x}$ in case it is known in advance. This method is especially useful when from each batch or a lot only one or two test results are generally available in routine testing.

A-1.2 It is still more important to check the variation of vital properties within a batch. There are a number of input materials like scrap, refractories, sand and ferro alloys which are heterogeneous in nature and exhibit variation from sample to sample. After a number of samples are tested for a particular property within a batch, the average quality of the batch can be expressed as $\bar{x} \pm 2s/\sqrt{n}$ where n is the number of samples tested. However, it is very unlikely that one gets a large number of samples tested from each incoming batch. In such cases, we may resort to control chart methods for monitoring the variation within a batch.

A-1.3 For this purpose, at least 2 samples from each batch shall be tested. The number could be increased to 4 or 5, if the testing is simple and not time consuming. From the data so collected for 20 or 25 batches one can establish $\bar{x}$, R charts as per IS 397 (Part 1) : 1972. It has, however, to be borne in mind that these control charts for incoming material are not action oriented as in the case of process control charts but only serve to forewarn the purchaser of the variation of the quality of the procured material so that a proper feedback may be given to the supplier to take remedial action at his end. Such method is especially useful in the procurement of bulk material like coke, ferro alloys, sand, etc.

A-2 PROCESS CONTROL

A-2.1 In-process inspection is a vital element in quality assurance and its main thrust is in the prevention of defectives at an early stage. For such inspection, efforts should be made to collect quantitative data at frequent intervals rather than simply recording the passing or failing of samples. For instance, apart from go, no-go gauges actual dimensional results at least for vital dimensions should be made available. Likewise, quality characteristics of sand batches, dimensions of mould while closing, temperature variation between different zones of baking oven, hardened properties of core sand mix, actual pouring temperature of different metals, temperature ranges in heat-treatment furnaces are some of the process parameters which can be monitored by process control charts [*see* IS 397 (Part 1) : 1972]. The number of the sample observations and the frequency of sampling will depend on the criticality of the characteristics and it could be reviewed on the basis of the behaviours of control charts over a period of time.

A-2.2 Quality control during production can build quality and reliability into the castings whereas inspection done later on will only sort out the good products from the bad ones. Because of the economy that would result by the former approach, it is recommended that the manufacturer should take representative samples of the material at regular intervals to control the quality fluctuations during the production.

Recommended frequencies of testing are given below.

Characteristics	*Frequency of Inspection or Testing*
Chemical analysis	One from each cast (melt)
Dimensional check	Each in case of intricate and special castings
	One for every 10 or part thereof in case of general castings
Mechanical tests	One for each casting in case of large, intricate and special castings. If the number of such castings from one heat is more than one, an integral test bar shall be provided with one casting and for the remaining castings a general test bar shall be prepared. In such cases, the general test bar shall be heat-treated together with other castings.
	One for every heat treatment batch in case of general casting.

NOTE — In case of large castings where the ruling section thickness is more than the thickness of the test block to be provided, it may be advisable to heat-treat such test blocks separately giving the similar heat-treatment cycle as recommended for the parent castings subject to the agreement between the purchaser and the supplier. By similar heat-treatment cycle, it is generally meant that the temperature range, rate of heating, cooling method, etc, will be the same as that of the parent castings but the soaking time will be different depending on the ruling section thickness.

A-2.3 The data so generated on a sequential basis, can be used for installing the process control charts for monitoring the process variation. In fact, for important characteristics process capability has to be evaluated and has to be checked against specification limits. For estimation of process capability and its interpretation guidance may be had from IS 10645 : 1983.

A-2.4 On the basis of process inspection data, the manufacturer may issue relevant test certificate to prove the conformity of a lot to the requirements of any specification.

When such test certificate cannot be made available to the purchaser or when the purchaser so desires, the procedure laid down in **5** shall be followed for judging the conformity or otherwise of a lot to the requirements of any specification.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

Doc : No. BSD 7 (279)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43
Southern : C.I.T. Campus, IV Cross Road, MADRAS 600113	235 0216
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	6 32 92 95

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at Swatantra Bharat Press, Delhi, India